Nitrogen and Phosphorous Reduction

of Seven Stormwater Plant Species

Malgorzata Rycewicz-Borecki

Presentation Outline

- Introduction
- Methods
- Results
- Conclusion

Introduction

Introduction

- Untreated stormwater runoff increases N and P discharged into downstream water bodies
- Cutler Reservoir watershed is included in Utah's "Impaired Waters" list from excess P and low DO (Wilbur, 2009)
- Mean seasonal total P concentrations are limited to 0.075 mg/L at Cutler Dam outfall (UDEQ, 2009)

Introduction

- Many municipalities (including Logan, UT) are required to implement on-site structural storm water BMPs (US EPA, 2006)
- Plants are often used to aid in the removal of pollutants
- This study measured individual plant species' ability to remove N and P from stormwater

Methods

Methods

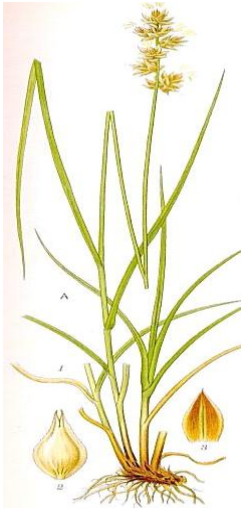
- Seven species typically found in stormwater BMPs:
  - Common Reed (*Phragmites communis*)
  - Broadleaf Cattail (*Typha latifolia*)
  - Soft-stem Bulrush (*Scirpus validus*)
  - Hard-stem Bulrush (*Scirpus acutus*)
  - Sedge A (*Carex praegracilis*)
  - Sedge B (*Carex microptera*)
  - Sunflower (*Helianphus maximillian*)
  - + controls

Common Reed

Cattail

Soft-stem Bulrush

Hard-stem Bulrush



Sedge A

Sedge B

Sunflower

Controls

Methods

- In a greenhouse the seven species were planted in triplicate, in 5 gal plastic totes
- BMP surface area is typically 3% of collection area.
- In subdivisions the runoff coefficient is 0.5

Methods

- EPA reports a storm duration and T^{IA} (average time interval between storms) for the northwest, inland rainzone
- Logan hourly rainfall data (2005-2010) used to calculate Logan's true duration, T^{IA} , and intensity values (as per Driscoll et al. 1986)

Methods

- ‘Rain events’ occurred every 6 days, for 14 hours, with 0.015 in/hr intensity (over the theoretical catchment area)
- Synthetic initial flush solutions (1.2 L) were added at the beginning of each rain event

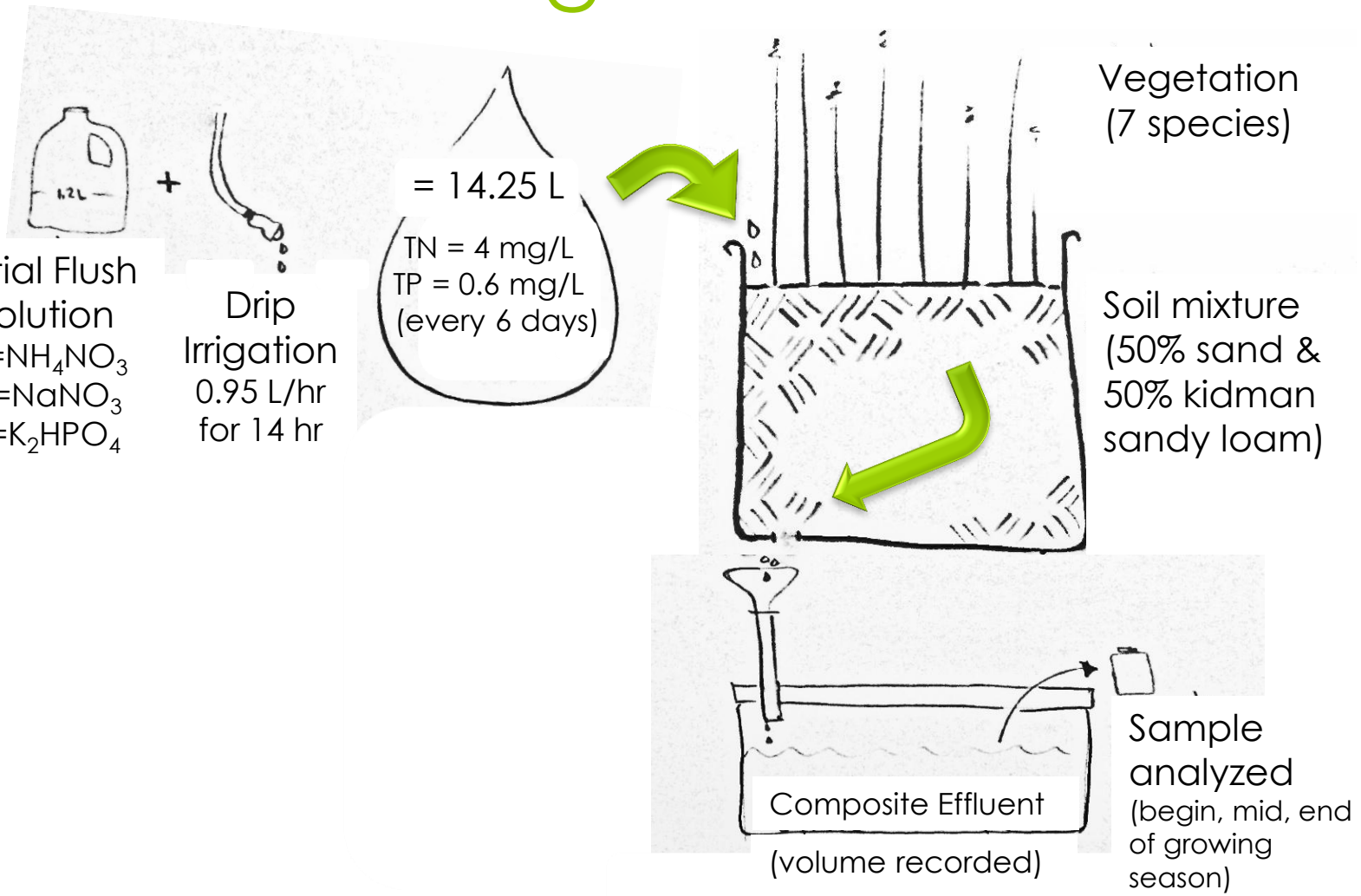
Methods

- A total of 14.25 L per tote per rain event representing runoff from theoretical catchment area for each tote

Methods

- Water, filtered through the tote (plant and soil), was collected 24 hrs after start of rain event
- Composite samples of effluent taken from each tote for TDN and TDP analysis at the UWRL
- Discharge volume recorded and used to calculate mass discharge of N and P

Method Diagram



Methods

- Sample and volume measurement of composite effluent taken at beginning, middle and end of 6 month growing season
- Samples collected in weeks 1-2-3, 14-15-16, and 25-26-27

Results

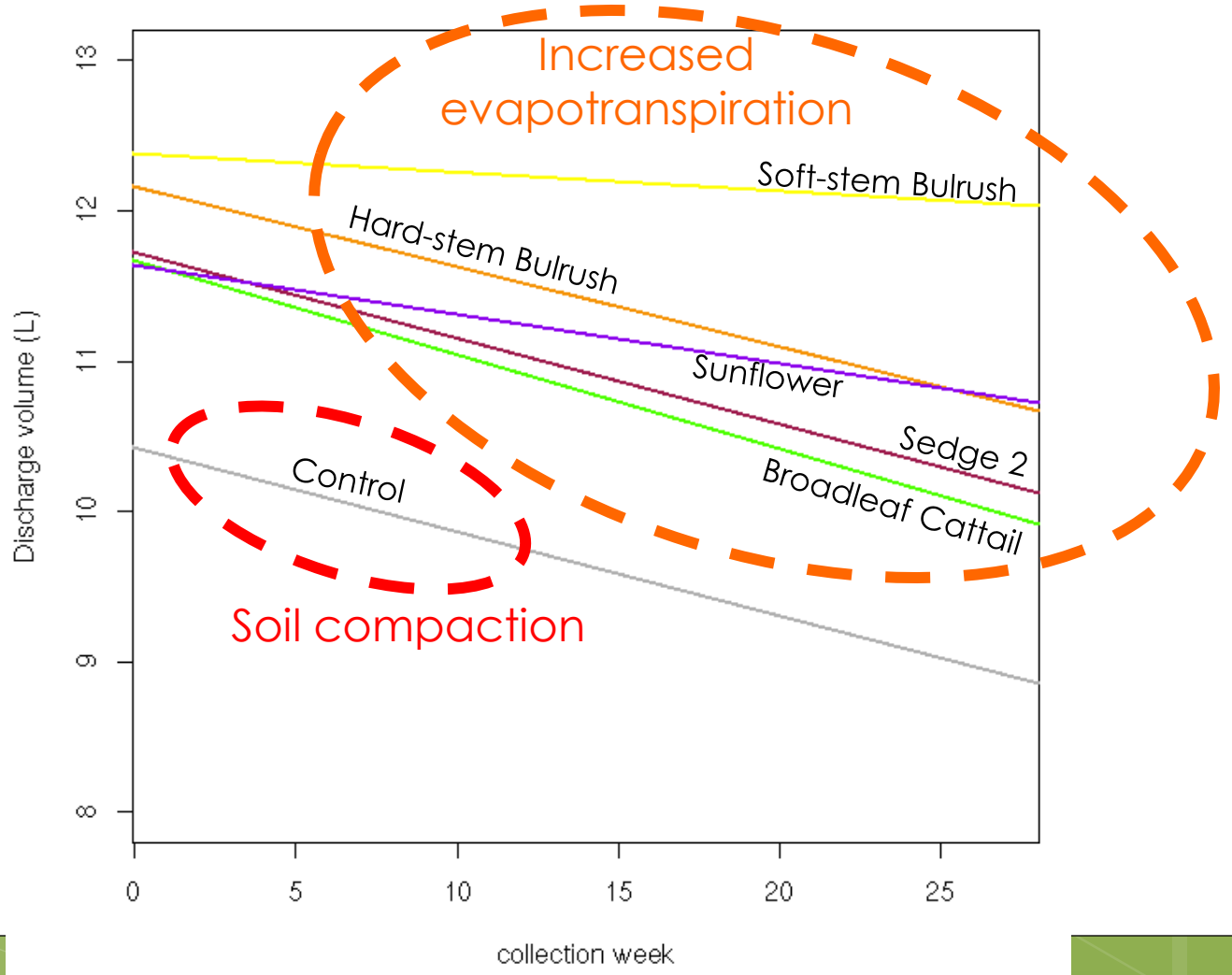
Results

- Effluent Volume over time
- N and P conc and mass discharge over time
- Average N and P discharge per species
- Average N and P discharge per total biomass

Legend

- Common Reed
- Broadleaf Cattail
- Soft-stem Bulrush
- Hard-stem Bulrush
- Sedge 1
- Sedge 2
- Sunflower
- Control

Discharge Vol over Time



Result

The discharge volume decreases from the beginning to the end of the growing season due to increased evapotranspiration (vegetated) or soil compaction (controls)

TDP concentration (mg/L)

Legend

- Common Reed
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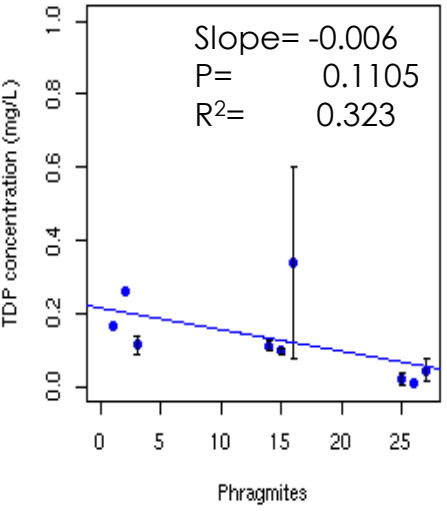
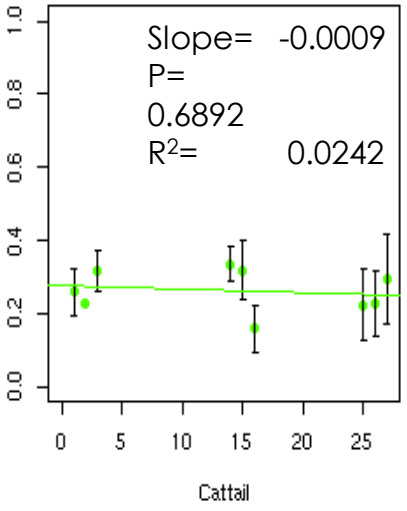
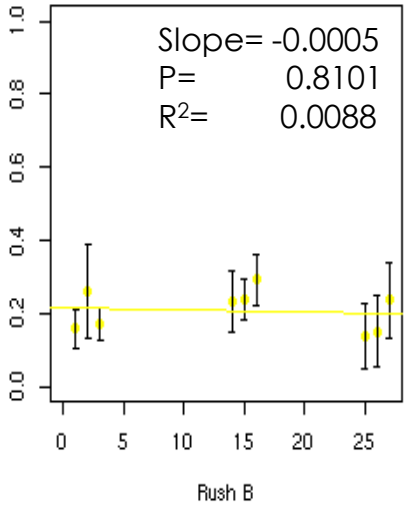
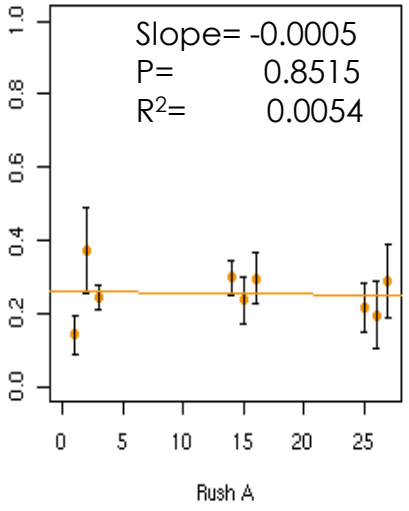
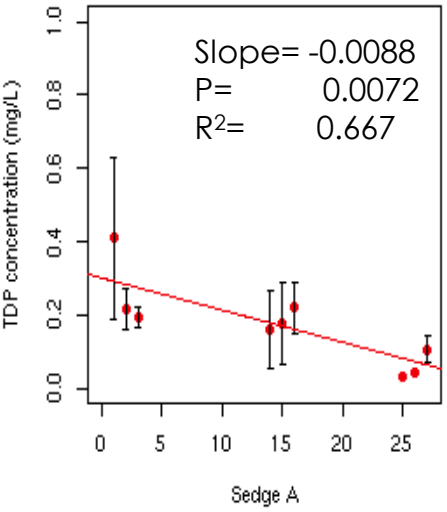
- Hard-stem Bulrush
- Sedge 1
- Sedge 2
- Sunflower
- Control

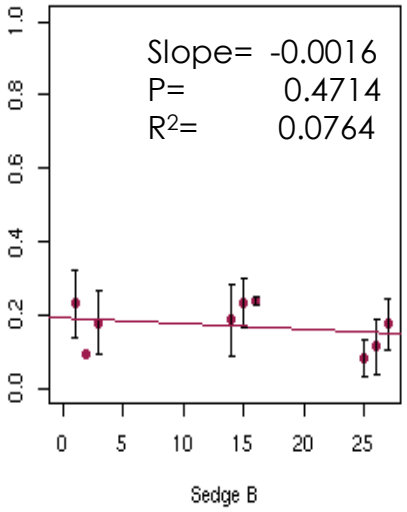


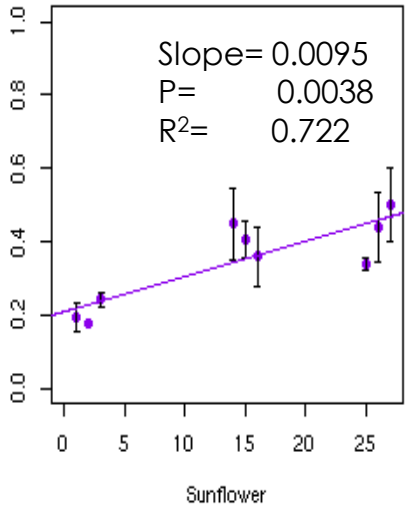


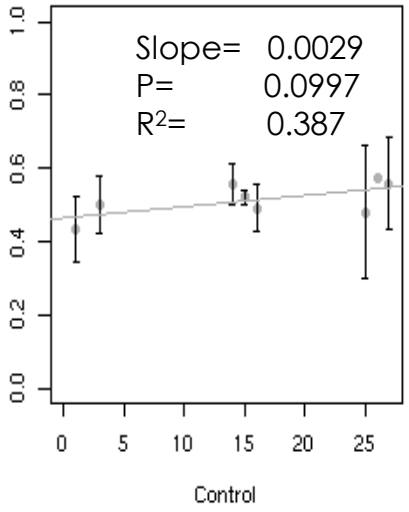












TDP mass discharge (mg)

Legend

- Common Reed
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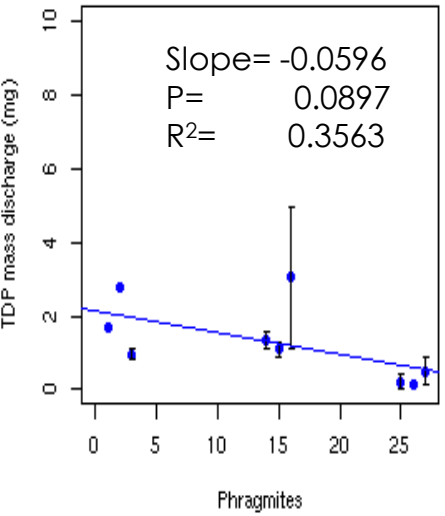
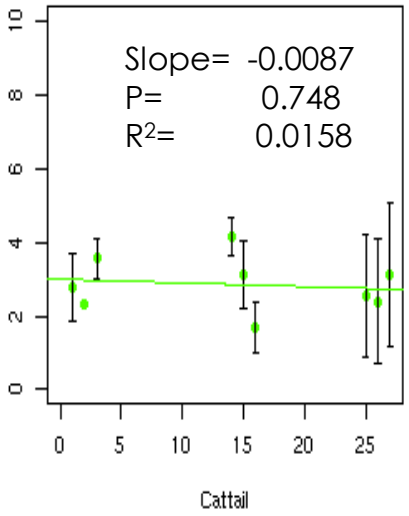
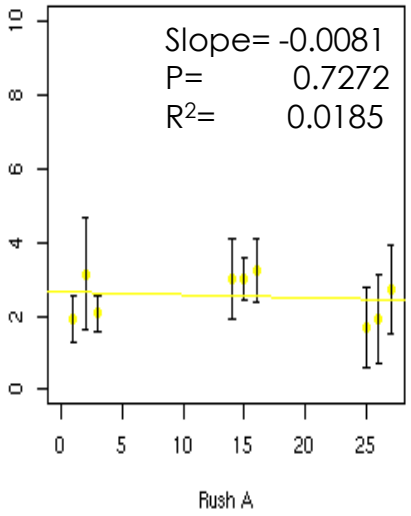
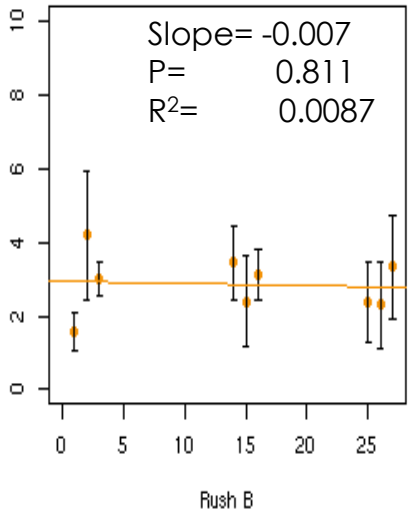
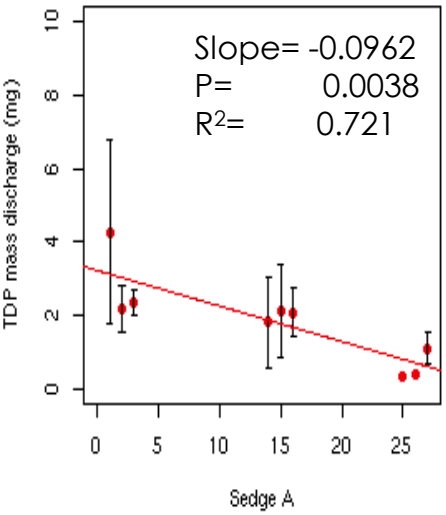
- Soft-stem Bulrush
- Hard-stem Bulrush
- Sedge 1
- Sedge 2
- Sunflower
- Control

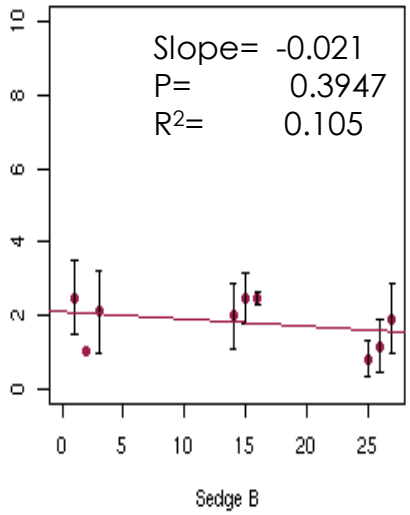


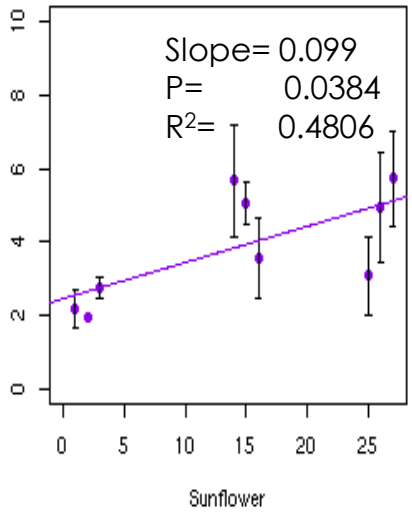


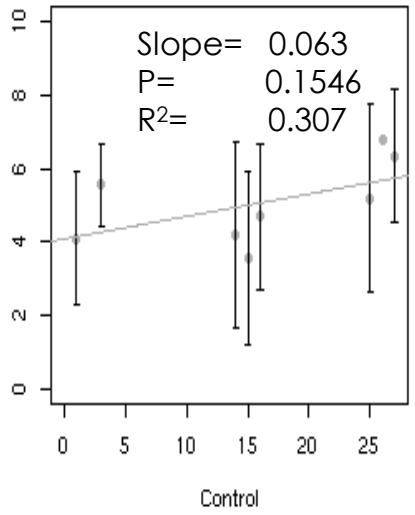












TDN concentration (mg/L)

Legend

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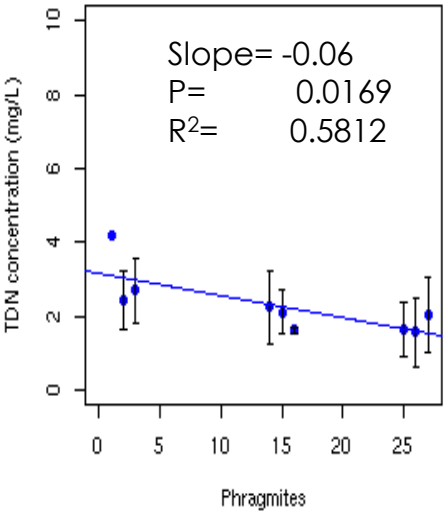

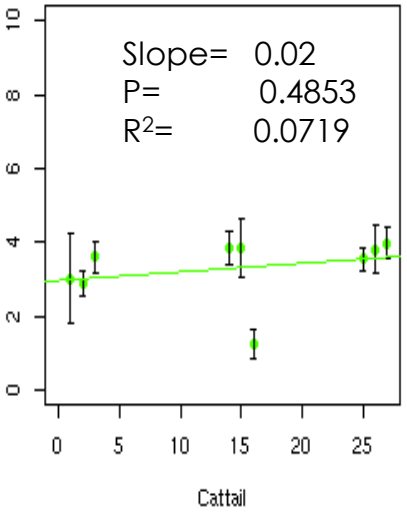

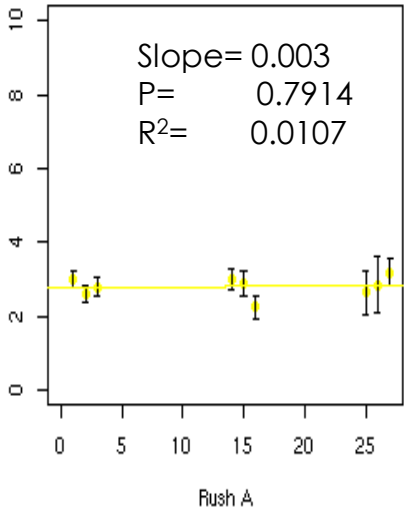

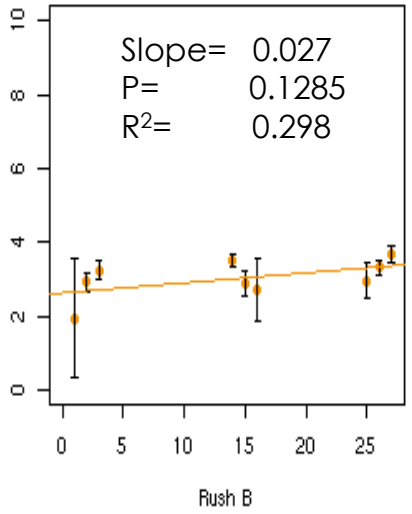

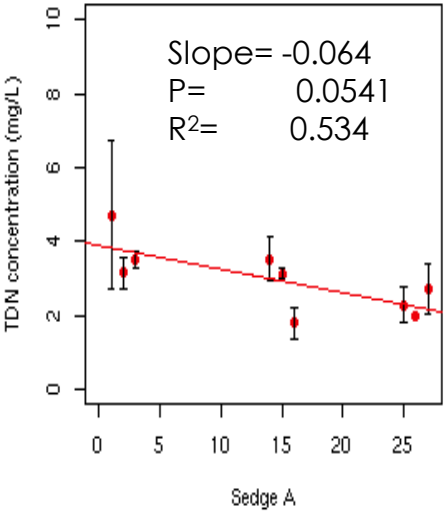

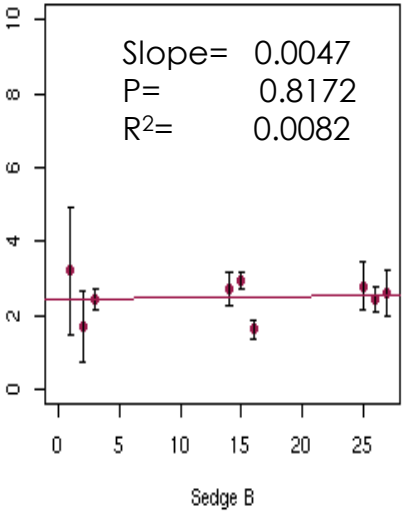

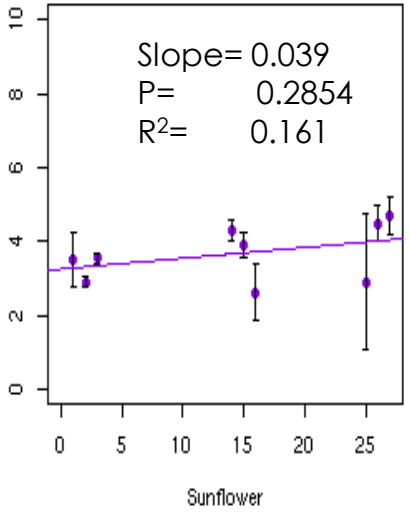

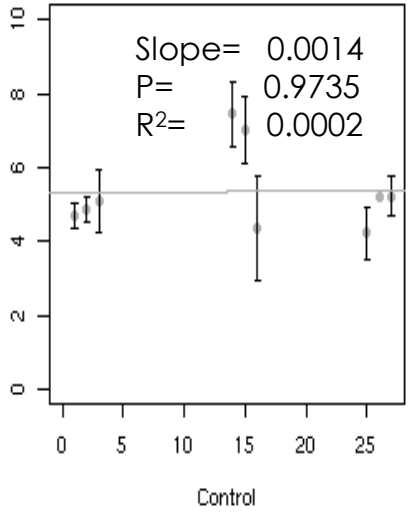

TDN mass discharge (mg)

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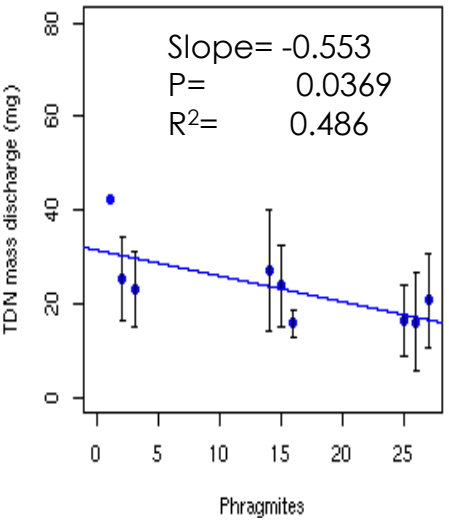
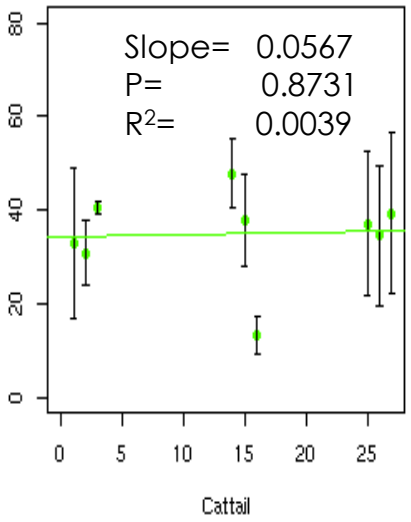
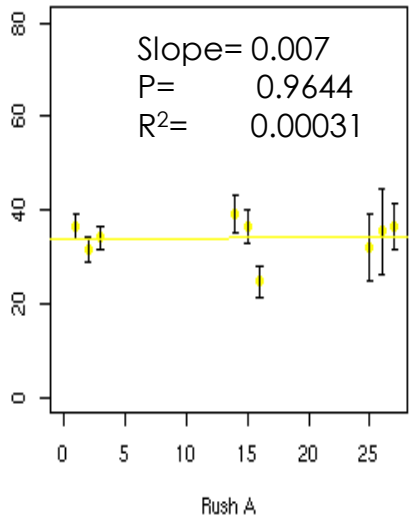
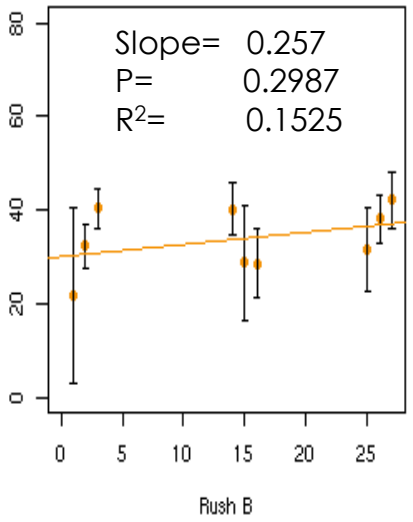
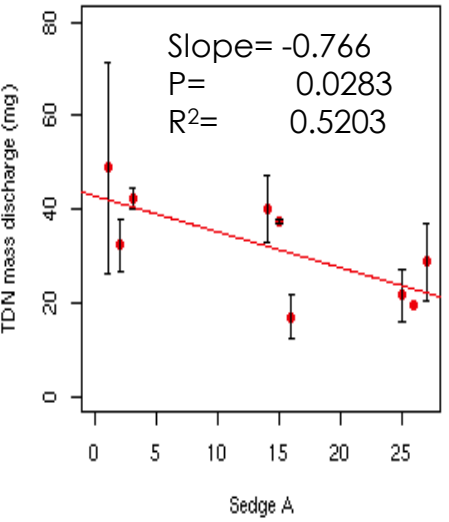
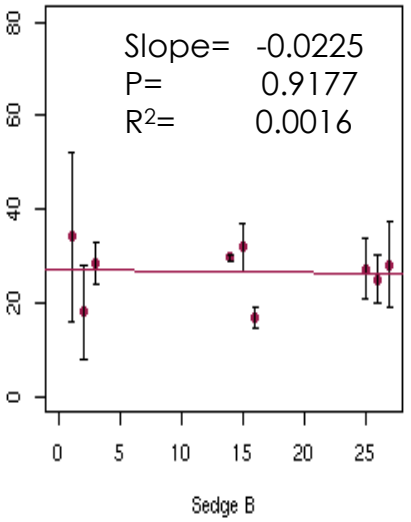


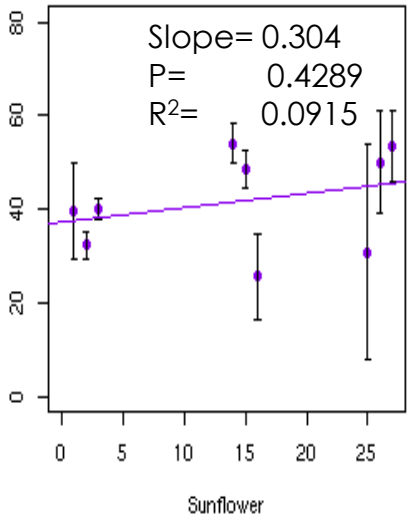


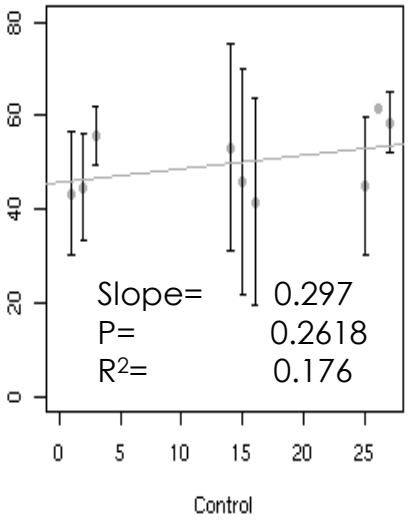










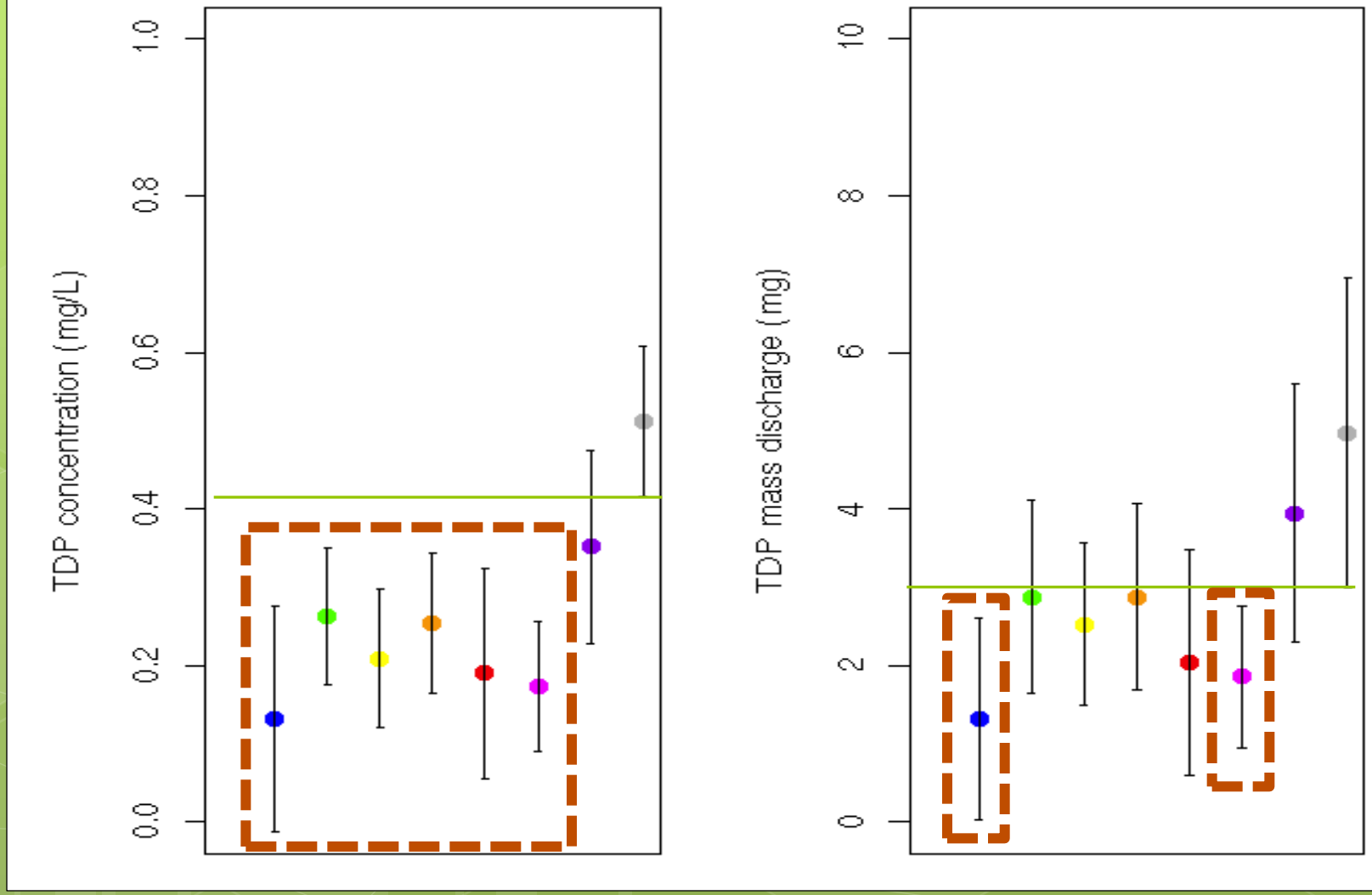


Result

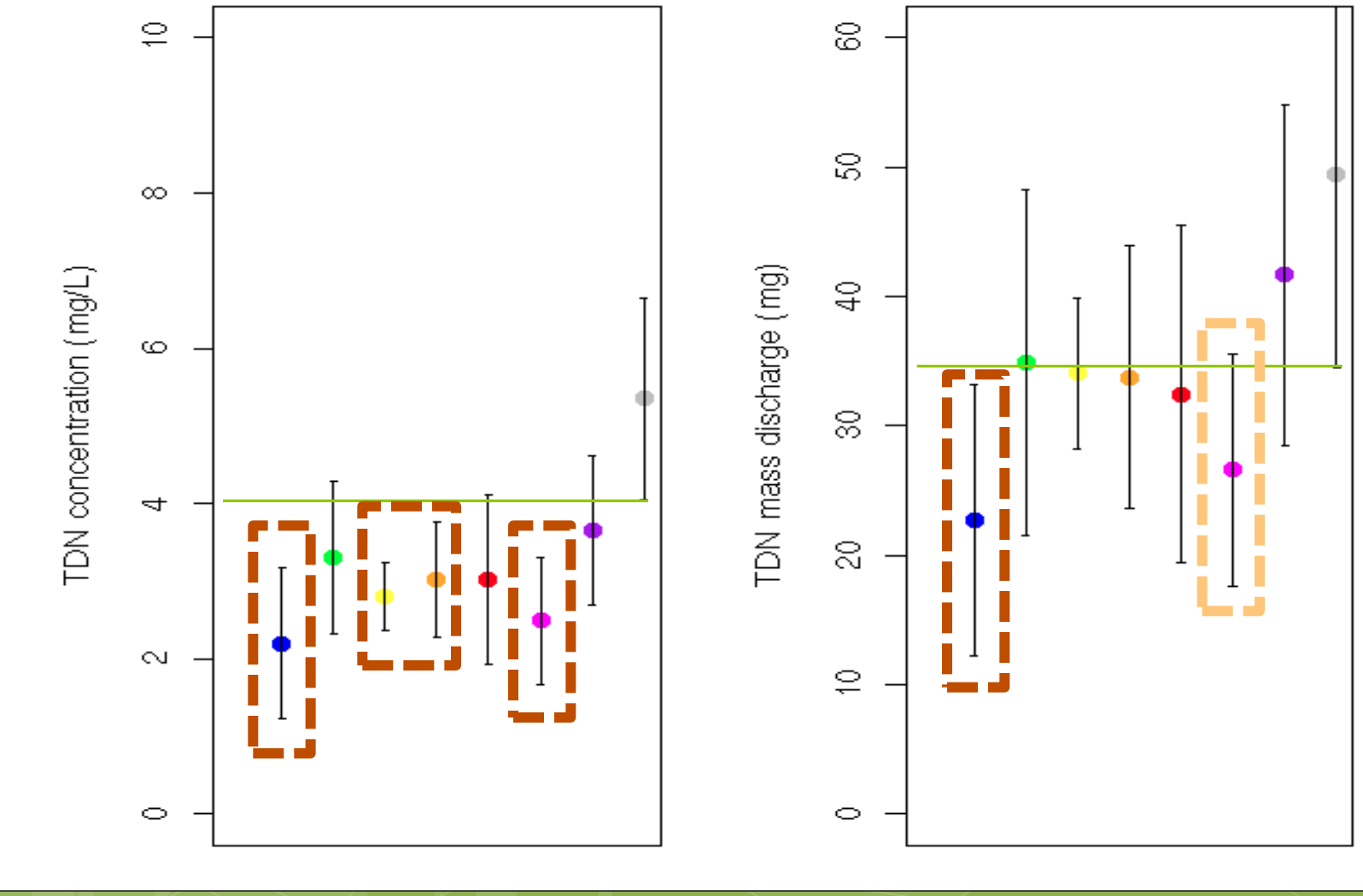
All treatments except Sunflower and Control decrease concentration and mass discharge of P over time.

Common Reed and Sedge A decrease concentration and mass discharge of N over time.

TDP per species



TDN per species

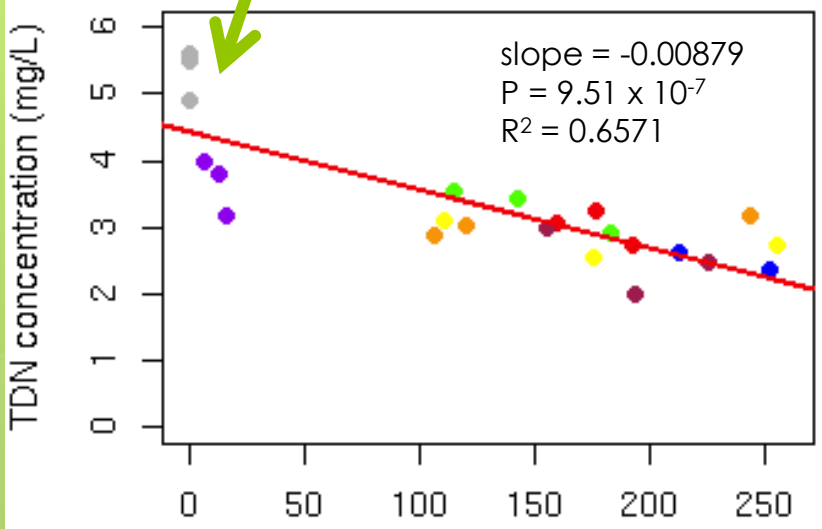


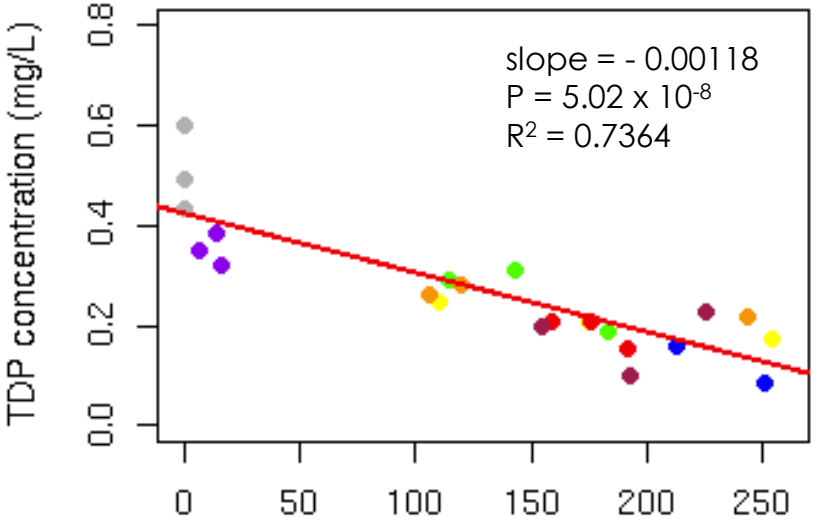
Result

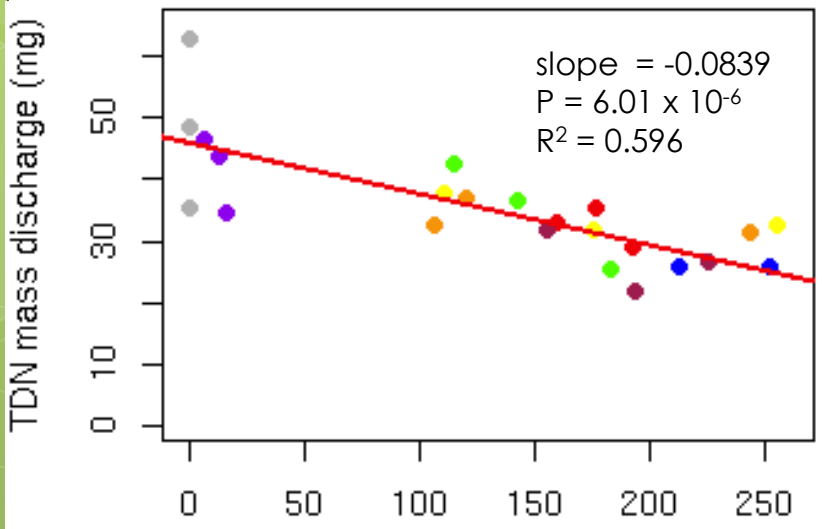
Controls had significantly higher N and P discharge **concentrations** than all treatments except sunflowers. However, only Common Reed and Sedge B had significantly lower **mass** discharge than controls

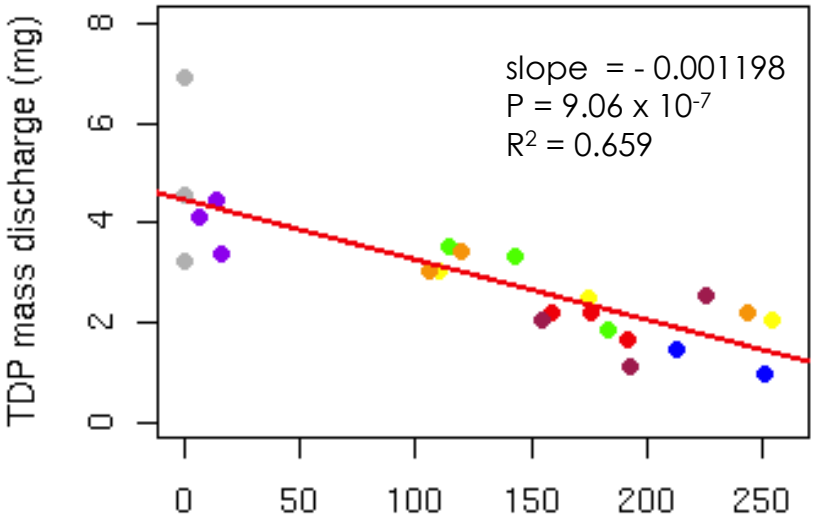
TDN & TDP vs. Biomass

Controls and Sunflowers









Result

Increased biomass yields lower N & P concentration and mass discharge

Conclusion

Conclusion

- **Volume** of water discharged is reduced over the growing season

- Common Reed and Sedge saw lower **concentrations** and **mass** discharges of N over time
- All vegetated treatments except sunflower saw lower **concentrations** and **mass** discharges of P over time

- All vegetated treatments except sunflower significantly lower N and P **concentrations** compared to non-planted control samples
- Common Reed and Sedge significantly lower N and P **mass** discharge compared to non-planted control samples

- N and P **concentration** and **mass** removal increases with total biomass production

Conclusion

- Proposed site design parameters for BMPs:
  - Plant and maintain more vegetation!
  - Irrigate to promote growth of desired species
  - Harvest vegetation and remove off-site

Questions?

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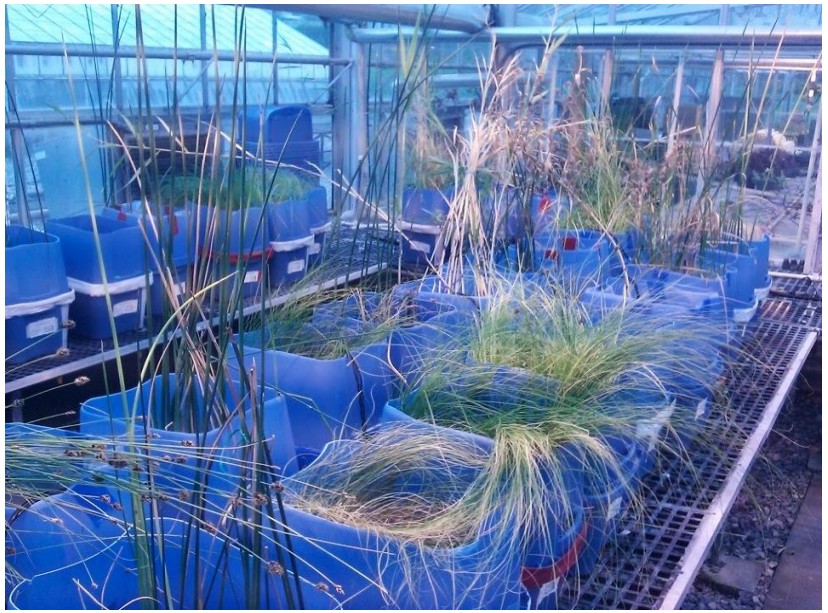

TDN & TDP vs. Biomass

Controls and Sunflowers